PATENT SPECIFICATION 935,276

DRAWINGS ATTACHED.

935,276

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COMPLETE SPECIFICATION.

Improvements of and relating to Zinc Casting Alloys.

We, STOLBERGER ZINK AKTIENGESELLSCHAFT FÜR BERGBAU UND HUTTENBETRIEB, of 37 Theaterstrasse, Aachen, Germany, a German Body Corporate, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

It is known that zinc alloys become very brittle at low temperatures. A measure of the toughness is the impact bending test, in which, for example, the impact bending strength (mkg./cm.^{2} or cmkg./mm.^{2}) is compared at ambient temperatures of 0° C. and −20° C. It is also known that the cold toughness of zinc alloys increases with increasing aluminium content (10% Al and above). However, this also raises the melting point, that is, the casting temperature, and thus also the solidification time. Higher cold toughness with higher aluminium contents leads therefore to properties which are undesirable in pressure casting.

The investigations described hereunder were therefore restricted to zinc alloys based on zinc 99.99% to 99.995% pure with Al-contents of 1 to 10%, using aluminium with a purity of 99.5 to 99.8%, copper contents of 0.1 to 5%, using electrolytic copper, and magnesium contents of over 0.005% to 0.05%, using 99.5% Mg. Particularly typical test results were obtained with alloys containing 3.5 to 4.3% Al, 0.6 to 1% Cu, 0.02 to 0.05% Mg (in the following Z 410) and alloys containing 1.5 to 3.5% Al, 0.8 to 1.5% Cu and 0.02 to 0.05% Mg (in the following Z 210). The impact bending values were measured with pressure cast bars 6.35 × 6.35 mm. With all series tests with a plurality of bars, there occurred considerable scattering of the impact bending values with all test temperatures so that good, practically acceptable results are also obtained at low temperatures.

As shown by older tests, the mould is filled in pressure casting in a fraction of a second, so that the pressurized melt is first vapourized and then combined with the following metal to form a quickly solidifying melt. This process produces a microporosity peculiar to pressure castings which—apart from vacuum pressure casting—is again affected by the oxidation of the vapourized melt.

With increasing oxide ratios, the impact bending strength of the pressure casting drops, and also the corrosion behaviour is less favourable.

It was now necessary to investigate whether the oxidation of the melt could be reduced during the short injection period into the mould. It is known that the formation of dross with alloys based on 99.99%, and preferably 99.995% fine zinc, and containing 0.1 to 10% Al, 0.05 to 1% Cu, and 0.001 to 0.1% beryllium, which may be replaced entirely or partly by zirconium and/or hafnium, may be avoided if the alloy is practically free from cadmium, alkali and earth alkali metals, especially magnesium, metals of the groups containing arsenic, antimony and tin, and the iron and silicon groups, phosphorus, carbon, boron, in which the maximum impurity content, especially of magnesium, may not exceed individually or jointly a value of 0.005%. It was now investigated to what extent this is the case, particularly with pressure casting of zinc-aluminium-copper-magnesium alloys, and which relation results for the impact bending strength between the given constituents and the predetermined beryllium contents. For alloys Z 410 and Z 210, which are charac-

[*Price 4s. 6d.*]

teristic for the series of alloys with 1 to 10% Al, 0.1 to 5% Cu, and 0.005 to 0.050% Mg, the impact bending values were determined always with 100 test bars, and the following minimum, maximum and mean values resulted :—

Alloy Z 410 :

Test temperature. °C.	Impact bending strength cmkg./mm.² from	to	mean values
40	4.5	8.5	7
40	4	8	6
0	1.5	7	4
−20	0.8	1.8	1.1

Already at 0° C. the minimum values drop considerably, although the maximum values do not yet indicate any embrittlement. The mimimum values at −20° C. are already critical.

Alloy Z 210 :

Test temperature. °C.	Impact bending strength cmkg./mm.² from	to	mean values
40	4	10	6
20	2	9	5.5
0	1.5	8.5	5
−20	1.3	2.5	1.8

In view of the higher melting point, this alloy must be cast at higher temperature ; the minimum values are lower than with Z 410. The alloy inclines slightly less to cold embrittlement.

In order to investigate the effect of beryllium, different beryllium and magnesium contents were necessary with every zinc-aluminium-copper alloy combination. The following results :—

Beryllium content under 0.0001% (1 g/t) have no effect on the impact bending strength at all. Of importance are only contents of more than 0.0001%, and especially from 0.0003% (3 g/t) beryllium. Be contents of 0.01% (100 g/t) or more reduce the impact bending strength due to the formation of beryllium or beryllium containing phases in the structure.

The present invention relates therefore to a zinc casting alloy, and more particularly to a zinc pressure casting alloy with high cold toughness, having the following composition :

1 to 10% aluminium.
0.1 to 5% copper.
Over 0.0005 to 0.05% magnesium.
Over 0.0001 to less than 0.01% beryllium.

Remainder zinc 99.99 to 99.995% pure.

In order to obtain maximum accumulation of maximum values the following correlated magnesium and baryllium contents are recommended :—

Mg contents %	Minimum Be content. %
0.005 to 0.010	0.0005 to 0.0015
0.010 to 0.020	0.0010 to 0.0030
0.020 to 0.030	0.0020 to 0.0040
0.030 to 0.040	0.0030 to 0.0050
0.040 to 0.050	0.0040 to about 0.0080

Alloys of this kind, tested in the form of Z 410 Be and Z 210 Be, give the following results :—

Z 410 Be :

Test temperature. °C.	Impact bending strength cmkg./mm.² from	to	mean values
40	6.5	12	9.5
20	6	11.5	9
0	5	11.5	8
−20	2.5	3.5	2.8

Z 210 Be :

Test temperature. °C.	Impact bending strength cmkg./mm.² from	to	mean values
40	7.5	13	10
20	7	12.5	10
0	6.5	11.5	9.5
−20	3	4.5	3.8

Both alloys have higher impact bending values at all temperatures, both in the minimum and maximum ranges and in the mean values. This may be seen from the accompanying graphs, showing in Fig. 1 the impact bending strength in cmkg./mm.^{2} of group Z 410 and Z 410 Be, and in Fig. 2 the impact bending strength of group Z 210 and Z 210 Be, where " Be " signifies that these alloys contain beryllium according to the invention. The mean values of these alloys are near or above the maximum values of the beryllium-free alloys, their minimum values are near or above the mean values of the baryllium-free alloys. In no case could a critical scattering value below 1.5 cmkg./mm.^{2} be observed.

The improved corrosion behaviour may be determined when testing the impact bending strength after 10 days' exposure to steam at 95° C. The following impact bending values resulted :—

Impact bending strength cmkg./mm.^{2} after 10 days' exposure to steam at 95° C. :—

	Z 410	Z 410 Be	Z 210	Z 210 Be
From	1.10	2.40	2.0	3.8
To	2.50	4.20	5.4	9.0
Mean	1.60	3.30	3.5	6.8

Conveniently, the beryllium is a preliminary alloy of aluminium-magnesium-beryllium, with, e.g.,

90—95% Al
5—3% Be
5—2% Mg

or of aluminium-copper-beryllium, with, e.g.,

50% Al
49.8% Cu
0.2% Be

Also preliminary alloys of aluminium-copper-magnesium, with, e.g.,

50% Al
48.8% Cu
1.0% Mg
0.2% Be

may be used.

The above-mentioned preliminary alloys may include as a diluent, in addition to the stated metals, zinc of 99.99 to 99.995% purity.

WHAT WE CLAIM IS :—

1. A zinc casting alloy, and more particularly a zinc pressure casting alloy with high cold toughness, having the following composition :—

1 to 10% aluminium.
0.1 to 5% copper.
Over 0.005 to 0.05% magnesium.
Over 0.001 to less than 0.01% beryllium.
Remainder zinc 99.99 to 99.995% pure.

2. An alloy as claimed in Claim 1, having the following correlated contents of magnesium and beryllium :—

Mg contents %	Minimum Be content %
0.005 to 0.010	0.0005 to 0.0015
0.010 to 0.020	0.0010 to 0.0030
0.02 to 0.030	0.0020 to 0.0040
0.03 to 0.040	0.0030 to 0.0050
0.04 to 0.050	0.0040 to about 0.0080

3. A method for producing the alloy as claimed in Claim 1 and 2, in which the beryllium is introduced into the melt in the form of a preliminary alloy.

4. A method as claimed in Claim 3, in which the beryllium is introduced as aluminium-magnesium-beryllium preliminary alloy with the following composition :—

90—95% Al
5—3% Be
5—2% Mg

5. A method as claimed in Claim 3, in which the beryllium is introduced as aluminium-copper-beryllium preliminary alloy with the following composition :—

50% aluminium
49.8% copper
0.2% beryllium

6. A method as claimed in Claim 3, in which the beryllium is introduced into the melt as aluminium-copper-magnesium-beryllium preliminary alloy with

50% aluminium
48.8% copper
1.0% magnesium
0.2% beryllium

7. A method as claimed in Claim 4, 5 or 6, in which the preliminary alloy includes as a diluent, in addition to the stated metals, zinc of 99.99 to 99.995% purity.

8. A zinc casting alloy as claimed in Claim 1 and a method for its manufacture as claimed in Claim 3, substantially as described herein.

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935276 COMPLETE SPECIFICATION

1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig.1

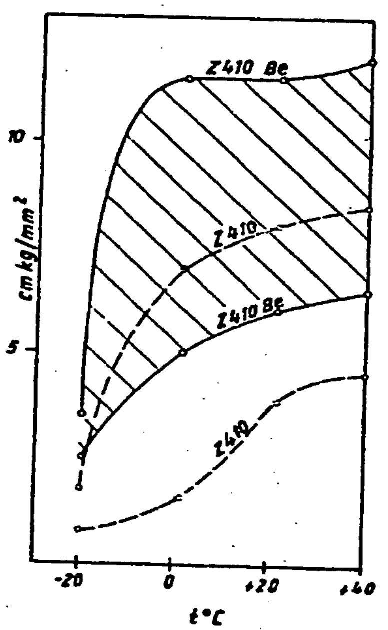

Fig. 2